CLAIMES

1. A surface-emission laser diode, characterized by:

a semiconductor substrate;

a cavity region formed over said semiconductor substrate, said cavity region comprising: an active layer structural part including at least one quantum well active layer producing a laser light and a barrier layer; and a spacer layer provided in a vicinity of said active layer structural part, said spacer layer comprising at least one material; and

an upper reflector and a lower reflector provided over said semiconductor substrate respectively at a top part and a bottom part of said cavity region,

said cavity region, said upper reflector and said lower reflector forming a mesa structure over said semiconductor substrate,

said upper reflector and said lower reflector constituting a semiconductor distributed

Bragg reflector having a periodic change of refractive index and reflecting an incident light by interference of optical waves,

at least a part of said semiconductor distributed Bragg reflector being formed of a layer of small refractive index of $Al_xGa_{1-x}As$ ($0<x\leq1$) and a layer of large refractive index of $Al_yGa_{1-y}As$ ($0\leq y<x\leq1$),

said lower reflector being formed of a first lower reflector having a low-refractive index layer of AlAs and a second lower reflector formed on said first lower reflector, said second lower reflector having a low-refractive index layer of AlGaAs,

wherein any one layer constituting said cavity region contains In.

2. The surface-emission laser diode as claimed in claim 1, characterized in that at least a lower spacer layer and an upper spacer layer contains In.

3. The surface-emission laser diode as claimed in claim 1, characterized in that, in said second lower reflector, said low refractive index

layer and said high refractive index layer are repeated by 10 pairs or less.

4. The surface-emission laser diode as claimed in claim 1, characterized in that a part of said spacer layer comprises $(Al_aGa_{1-a})_bIn_{1-b}P$ ($0<a\leq1$, $0\leq b\leq1$), said quantum well active layer comprises $Ga_cIn_{1-c}P_dAs_{1-d}$ ($0\leq c\leq1$, $0\leq d\leq1$), and said barrier layer comprises $Ga_eIn_{1-e}P_fAs_{1-f}$ ($0\leq e\leq1$, $0\leq f\leq1$).

5. The surface-emission laser diode as claimed in claim 4, characterized in that said quantum well active layer has a compressive strain.

6. The surface-emission laser diode as claimed in claim 5, characterized in that said barrier layer has a tensile strain.

7. The surface-emission laser diode as claimed in claim 4, characterized in that said semiconductor substrate comprises a (100) GaAs substrate having a surface orientation inclined in a direction of a (111)A surface with an angle in a range of 5° to 20°.

8. The surface-emission laser diode as claimed in claim 4, characterized in that said surface-emission laser diode has an oscillation wavelength of about 680nm or longer.

9. The surface-emission laser diode as claimed in claim 5, characterized in that said semiconductor substrate comprises a (100) GaAs substrate having a surface orientation inclined in a direction of a (111)A surface by an angle in a range of 5° to 20°.

10. The surface-emission laser diode as claimed in claim 5, characterized in that said surface-emission laser diode has an oscillation wavelength of about 680nm or longer.

11. A surface-emission laser diode, characterized by:

a (100) GaAs substrate having a surface orientation inclined in a direction of a (111)A surface by an angle of 5° to 20°;

a cavity region provided over said GaAs substrate, said cavity region including an active layer structural part comprising at least one layer

of quantum well active layer producing a laser light and barrier layers, and a spacer layer provided in a vicinity of said active layer structural part, said spacer layer comprising at lease one material; and

an upper reflector and a lower reflector provided at a top part and a bottom part of said cavity region,

said cavity region and said upper and lower reflectors forming a mesa structure over said GaAs substrate,

said upper reflector and said lower reflector comprising a semiconductor distributed Bragg reflector having a periodic change of refractive index and reflecting an incident light by interference of optical waves,

at least a part of said semiconductor distributed Bragg reflector being formed of a layer of small refractive index of $Al_xGa_{1-x}As$ ($0<x\leq1$) and a layer of large refractive index of $Al_yGa_{1-y}As$ ($0\leq y<x\leq1$),

a part of said spacer layer comprising $(Al_aGa_{1-a})_bIn_{1-b}P$ ($0<a\leq1$, $0\leq b\leq1$),

said quantum well active layer comprising $Ga_cIn_{1-c}P_dAs_{1-d}$ ($0\leq c\leq1$, $0\leq d\leq1$),

said barrier layers comprising $Ga_eIn_{1-e}P_fAs_{1-}$

$_f$ ($0 \leq e \leq 1$, $0 \leq f \leq 1$),

said quantum well active layer having a compressive strain,

said active layer structural part having a shape anisotropy elongated in a direction of a (111)A surface as viewed from a direction of light emission.

12. The surface-emission laser diode as claimed in claim 11, characterized in that said barrier layer has a tensile strain.

13. The surface-emission laser diode as claimed in claim 11, characterized in that said surface-emission laser diode has an oscillation wavelength of about 680nm or longer.

14. A method of fabricating a surface emission laser diode, said surface emission layer diode comprising, over a semiconductor substrate: a cavity region comprising an active layer structural part including at least one quantum well active layer producing a laser light and barrier layers, and a spacer layer of at least one material provided in a vicinity of said active layer structural part; and an upper reflector and a lower reflector provided at a

top part and a bottom part of said cavity region, characterized in that said method comprises the steps of:

forming a stacked structure including said lower reflector, said cavity region and said upper reflector over said semiconductor substrate; and

forming a mesa structure by patterning said stacked film by dry etching,

said step of forming said stacked structure including a step of incorporating In to any one layer constituting said cavity region,

said step of forming said mesa structure by said dry etching comprises a step of controlling a height of said mesa structure by monitoring light emission of In.

15. A surface-emission laser diode, comprising:

a GaAs substrate;

a cavity region formed over said GaAs substrate, said cavity region including at least one quantum well active layer producing a laser light and barrier layers; and

an upper reflector and a lower reflector provided at a top part and a bottom part of said

cavity region over said GaAs substrate,

said upper reflector and/or said lower reflector including a semiconductor Bragg reflector,

at least a part of said semiconductor distributed Bragg reflector comprising a semiconductor layer containing Al, Ga and As as major components,

wherein there is provided, between said active layer and said semiconductor layer that contains Al, Ga and As as major components, a semiconductor layer containing Al, In and P as major components such that said semiconductor layer containing Al, In and P as major components is provided adjacent to said semiconductor layer that contains Al, Ga and As as major components,

an interface between said semiconductor layer containing Al, Ga and As as major components and said semiconductor layer containing Al, In and P as major components being formed coincident to a location of a node of electric field strength distribution.

16. The surface-emission laser diode as claimed in claim 15, characterized in that said semiconductor layer containing Al, In and P as major

components comprises $(Al_aGa_{1-a})_bIn_{1-b}P$ ($0<a\leq1$, $0\leq b\leq1$).

17. The surface-emission laser diode as claimed in claim 15, characterized in that

there is provided a spacer layer between said active layer and said upper reflector and/or lower reflector, a part of said spacer layer comprising an AlGaInP layer,

said quantum well active layer comprises $Ga_cIn_{1-c}P_dAd_{1-d}$ ($0\leq c\leq1$, $0\leq d\leq1$), and

said barrier layer comprises $Ga_eIn_{1-e}P_fAs_{1-f}$ ($0\leq e\leq1$, $0\leq f\leq1$).

18. The surface-emission laser diode as claimed in claim 17, characterized in that said quantum well active layer has a compressive strain.

19. The surface-emission laser diode as claimed in clam 18, characterized in that said barrier layer has a tensile strain.

20. A surface-emission laser diode, characterized by :

a GaAs substrate;

a cavity region formed over said GaAs

substrate and having at least one quantum well active layer producing a laser light and barrier layers; and

an upper reflector and a lower reflector provided at a top part and a bottom part of said cavity region over said GaAs substrate,

said upper reflector and/or lower reflector including a semiconductor distributed Bragg reflector,

at least a part of said semiconductor distributed Bragg reflector comprising a semiconductor layer containing Al, Ga and As as major components,

there being provided, between said active layer and said semiconductor layer containing Al, Ga and As as major components, a $(Al_aGa_{1-a})_bIn_{1-b}P$ ($0<a\leq1$, $0\leq b\leq1$) layer adjacent to said semiconductor layer containing Al, Ga and As as major components,

said $(Al_aGa_{1-a})_bIn_{1-b}P$ ($0<a\leq1$, $0\leq b\leq1$) layer being added with Mg (magnesium) as a p-type dopant,

said semiconductor layer containing Al, Ga and As as major components being added with C (carbon) as a p-type dopant.

21. The surface-emission laser diode as

claimed in claim 20, characterized in that

there is provided a spacer layer between said active layer and said upper reflector and/or lower reflector, a part of said spacer layer comprising an AlGaInP layer,

said quantum well active layer comprises $Ga_cIn_{1-c}P_dAd_{1-d}$ ($0 \leq c \leq 1$, $0 \leq d \leq 1$), and

said barrier layer comprises $Ga_eIn_{1-e}P_fAs_{1-f}$ ($0 \leq e \leq 1$, $0 \leq f \leq 1$).

22. The surface-emission laser diode as claimed in claim 21, characterized in that said quantum well active layer has a compressive strain.

23. The surface-emission laser diode as claimed in clam 22, characterized in that said barrier layer has a tensile strain.

24. A surface-emission laser diode, comprising:

a GaAs substrate;

a cavity region formed over said GaAs substrate, said cavity region including at least one quantum well active layer producing a laser light and barrier layers; and

an upper reflector and a lower reflector provided at a top part and a bottom part of said cavity region over said GaAs substrate,

said upper reflector and/or lower reflector including a semiconductor distributed Bragg reflector,

at least a part of said semiconductor distributed Bragg reflector comprising a semiconductor layer containing Al, Ga and As as major components,

there being provided, between said active layer and said semiconductor layer containing Al, Ga and As as major components, a $(Al_aGa_{1-a})_bIn_{1-b}P$ ($0<a\leq1$, $0\leq b\leq1$) layer adjacent to said semiconductor layer containing Al, Ga and As as major components,

said $(Al_aGa_{1-a})_bIn_{1-b}P$ ($0<a\leq1$, $0\leq b\leq1$) layer being a semiconductor layer formed of a short period superlattice structure of AlInP and GaInP.

25. The surface-emission laser diode as claimed in claim 24, characterized in that

there is provided a spacer layer between said active layer and said upper reflector and/or lower reflector, a part of said spacer layer comprising an AlGaInP layer,

said quantum well active layer comprises

$Ga_cIn_{1-c}P_dAd_{1-d}$ ($0 \leq c \leq 1$, $0 \leq d \leq 1$), and

said barrier layer comprises $Ga_eIn_{1-e}P_fAs_{1-f}$ ($0 \leq e \leq 1$, $0 \leq f \leq 1$).

26. The surface-emission laser diode as claimed in claim 25, characterized in that said quantum well active layer has a compressive strain.

27. The surface-emission laser diode as claimed in clam 25, characterized in that said barrier layer has a tensile strain.

28. A surface-emission laser diode, comprising:

a GaAs substrate;

a cavity region formed over said GaAs substrate, said cavity region including at least one quantum well active layer producing a laser light and barrier layers; and

an upper reflector and a lower reflector provided at a top part and a bottom part of said cavity region over said GaAs substrate,

said upper reflector and/or lower reflector including a semiconductor distributed Bragg reflector,

at least a part of said semiconductor distributed Bragg reflector comprising a low refractive index layer of $Al_xGa_{1-x}As$ ($0<x\leq1$) and a high refractive index layer of $Al_yGa_{1-y}As$ ($0\leq y<x\leq1$),

one of said low refractive index layers constituting said upper reflector and/or said lower reflector and located closest to said active layer comprising $(Al_aGa_{1-a})_bIn_{1-b}P$ ($0<a\leq1$, $0\leq b\leq1$),

an interface between said cavity region and said low refractive index layer of said upper reflector and/or said lower reflector located closest to said active layer being coincident to an anti-node of an electric strength distribution.

29. The surface-emission laser diode as claimed in claim 28, characterized in that said lower reflector comprises, consecutively from said substrate, a first lower reflector containing an AlAs layer as said low refractive index layer, a second lower reflector including $Al_{x1}Ga_{1-x1}As$ ($0<x_1<1$) as said low refractive index layer, and at least one $(Al_aGa_{1-a})_bIn_{1-b}P$ ($0<a\leq1$, $0\leq b\leq1$) low refractive index layer.

30. The surface-emission laser diode as claimed in calm 28, characterized in that said high

refractive index layer comprises $Al_yGa_{1-y}As$ ($0 \leq y < x \leq 1$), said low refractive index layer comprises $(Al_aGa_{1-a})_bIn_{1-b}P$ ($0 < a \leq 1$, $0 \leq b \leq 1$), wherein there is provided an intermediate layer $(Al_{a1}Ga_{1-a1})_{b1}In_{1-b1}P$ ($0 \leq a_1 < a \leq 1$, $0 \leq b_1 \leq 1$) having an Al content smaller than said $(Al_aGa_{1-a})_bIn_{1-b}P$ ($0 < a \leq 1$, $0 \leq b \leq 1$) low refractive index layer at an interface between said high refractive index layer and said low refractive index layer.

31. The surface-emission laser diode as claimed in claim 28, characterized in that there is provided a spacer layer between said active layer and said upper reflector and/or lower reflector,

a part of said spacer layer comprising $(Al_aGa_{1-a})_bIn_{1-b}P$ ($0 < a \leq 1$, $0 \leq b \leq 1$) having a bandgap smaller than that of said AlGaInP low refractive index layer,

said quantum well active layer comprising $Ga_cIn_{1-c}P_dAs_{1-d}$ ($0 \leq c \leq 1$, $0 \leq d \leq 1$),

said barrier layer comprising $Ga_eIn_{1-e}P_fAs_{1-f}$ ($0 \leq e \leq 1$, $0 \leq f \leq 1$).

32. The surface-emission laser as claimed in claim 31, characterized in that said quantum well active layer has a compressive strain.

33. The surface-emission laser diode as claimed in claim 32, characterized in that said barrier layer has a tensile strain.

34. The surface-emission laser diode as claimed in claim 28, characterized in that said low refractive index layer of $Al_xGa_{1-x}As$ ($0<x\leq1$) and said high refractive index layer of $Al_yGa_{1-y}As$ ($0\leq y<x\leq1$) of said semiconductor distributed Bragg reflector are doped with a p-type dopant of C (carbon), and wherein said low-refractive index of $(Al_aGa_{1-a})_bIn_{1-b}P$ ($0<a\leq1$, $0\leq b\leq1$) is doped with a p-type dopant of Mg (magnesium).

35. The surface-emission laser diode as claimed in claim 28, characterized in that said low-refractive index of $(Al_aGa_{1-a})_bIn_{1-b}P$ ($0<a\leq1$, $0\leq b\leq1$) is constructed by a short period superlattice structure of AlInP and GaInP.